# Energy from the Sun

| Preparation Time: | Easy-to-do | Moderate | **Extensive** |
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| **Grade:** | 6 – 8 |
| **Focus:** | Solar energy |
| **Subject:** | Science, Math |
| **Materials:** | See list below |
| **Teaching Time:** | One class period |
| **Vocabulary:** | Solar energy, active systems, passive systems, photovoltaic systems, hybrid systems |

### Learning Objectives

In this activity, students will:

- measure the amount of solar energy that comes from the sun; and
- describe ways this energy may be used to help reduce our dependence on traditional fossil fuels and nuclear power.

### Background

The following is reprinted with permission from the "Energy Factbook: A Resource for South Carolina."

The sun is the most powerful energy resource. It heats the planet and nourishes plants used for food. Without the sun, nothing could exist.

The energy from the sun is there for the taking. It is not only free, it never runs out. If all the sun's energy that falls on one square meter of the Earth's surface for one hour could be harnessed, a whole city could be lit for one year. Also, the energy from the sun poses no environmental hazards.

With these many advantages, why is **solar energy** not being used to meet all of our energy needs? The answer is that tapping the sun's energy is not a straightforward process.

For maximum use of the sun, it must be constantly available. Yet, even under ideal weather conditions, the sun does not shine 24 hours a day, 365 days a year. To be useful, sunlight must be collected, moved to where it is needed and stored. This is no easy challenge.

People have been using the sun's energy for thousands of years for space and water heating purposes. Utilizing the sun's energy is categorized into four main types of systems: (1) **active systems**; (2) **passive systems**; (3) **photovoltaic systems**; and (4) **hybrid systems**.

The last, a hybrid system, is some combination of the other systems. In all of the systems, they must face the sun in order to work. For the northern hemisphere of the earth, where we live, the sun moves across the sky during the day from the southeast to the southwest. This creates the problem of where to face the system to get the maximum amount of energy from the sun. The answer is to position the system so that it faces due south, or only slightly east or west of south.

Active solar systems use mechanical equipment such as pumps and fans to move energy around. There are two types of active systems; one is for space heating and the other is for water heating. A house using active space heating will have to face south, with most of its windows on the south wall. This allows winter sunlight to enter the house,

**DOWN to Earth**

***One of the most promising solar-to-electric conversion technologies is Photovoltaic (PV) cells, made of thin layers of specially treated silicon or other semi-conductive materials that convert sunlight into electricity. The cells can be wired together to deliver a greater volume of electricity. PV technology is appealingly low-maintenance because no moving parts are required for the conversion process.***

***Source: Electric Power Research Institute***

thereby heating the air inside. This heated air is then circulated throughout the house by fans.

When sunlight passes through glass into an enclosed space, the wavelength of the light changes. This new wavelength cannot pass back through the glass, thereby entrapping it in the house. This is known as the greenhouse effect. Think of it just like getting into the car on a cold winter day and finding the inside of the car warm.

More equipment needs to be added to the system if night time heating is necessary. The air is heated in collectors and circulated through a rock bed storage compartment. This is an insulated box which contains small rocks. These rocks are heated during the day, and at night, the air inside the home is circulated through the rock bed. As it passes through the rocks, it extracts the stored heat, and heated air is circulated back through the house.

Water heating systems are more complicated than space systems and can be used year round. A collector panel is mounted on the roof (facing south). This consists of an insulated box with a clear glass or plastic cover. Inside this panel are many copper pipes and fins. These pipes are painted black to absorb and conduct the sun’s heat to the water that is pumped through them.

This collector panel is attached to the water heater tank which is located inside the house. The water is circulated between the collector and the water tank by electric pumps. Cold water is pumped from the water tank to the collector and hot water is pumped back from the collector to the water tank. Thermosensors, which recognize changes in temperature, tell the pump when to turn on and off.

Passive solar systems do not use any mechanical equipment to move energy. In these systems, the actual building components become part of the system. These components, or thermal storage materials, are used to store heat during the day for use at night. Among the most commonly used thermal storage materials are tile, concrete, brick and water. All of these materials are very good at absorbing and holding heat.

As with all systems that utilize solar energy, location is the most important consideration in designing a passive solar house. To be most effective, the windows in a passive solar house must face south. In this position, they will be exposed to maximum sunlight. In addition, insulation should be placed around the glass to reduce heat loss. Windows, doors and walls need to be free of leaks so that trapped heat stays trapped.

Outside landscaping is another important part of passive solar systems. For example, evergreen trees that won’t lose their leaves in winter can be planted on the north side of a home to provide winter wind protection. Trees that lose their leaves in winter can likewise be planted on the south side of a home to give it access to winter sunlight and to protect it from hot, summer sunshine.

Photovoltaic systems convert radiant energy from the sun into electricity. While photovoltaic technology has been around for 150 years, its actual commercial development did not occur until 1954. It was first used in 1958 to provide electric power for U.S. spacecraft and satellites.

The cost of producing electricity through photovoltaic technology has dropped significantly in the past few years. Prices have gone from more than $50 per kilowatt to less than $0.30 per kilowatt. Photovoltaic systems, once seen as too expensive, are being used more frequently.

Photovoltaic systems are often used in remote areas where it is too expensive for power companies to bring in electric power lines. They also are being used to light road signs and power radio transmitters. Researchers developing electric cars also are making use of photovoltaic technology. Scientists at York Technical College in South Carolina, for example, are among those working hard to improve this technology.

## Materials

This activity works well for small groups of students. For each student group performing the experiment, you'll need:

- two glass jars (same size);
- two thermometers;
- food coloring;
- aluminum foil;
- a measuring cup;
- a metric ruler;
- a watch with a second hand;
- insulation materials (packing foam, shredded newspaper, etc.);
- a cardboard box (it should be the same height as the cups, trim the box if needed);
- cold water; and
- access to direct sunlight.

## Learning Procedure

1. Review with the class the background information on solar energy. **Ask:** How can we measure solar energy? (Solar energy is measured as heat or calories.)

2. Have students work in small groups to perform this experiment to measure solar energy. Have each group record their results.

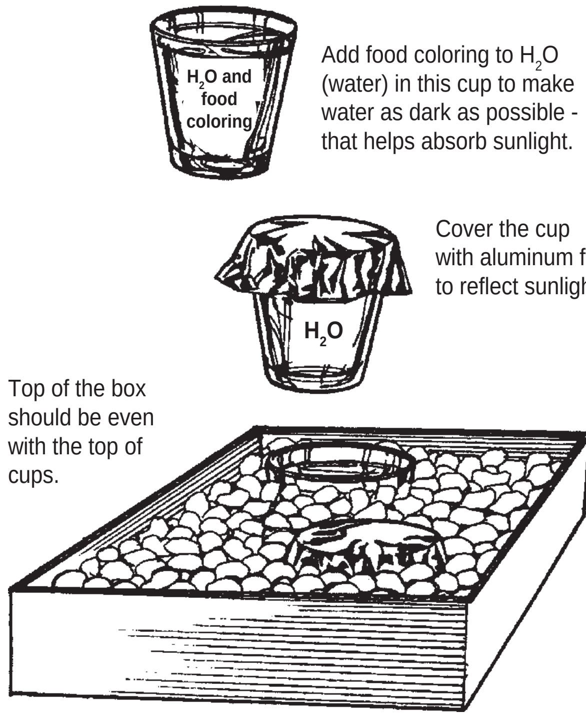
3. To set up the experiment, have students follow these steps.

   - Fill two glass jars with a measured amount of very cold water. (Set a standard amount for students to use based on the size of the cups.)

   - Add several drops of food coloring to one cup to make the water turn dark. (Make the water as dark as possible. Darker colors absorb more sunlight.)

   - Cover the top of the other cup of water with a piece of aluminum foil. (The foil will reflect the sun.)

   - Place the cups in the cardboard box. (Be sure to trim the box if necessary so that the height is the same as the cups.)




Pack insulation into all spaces around cups.

   - Add insulation material around the cups (see the illustration above).

   - Place the box in the sun for 10 minutes. The hottest time of the day is usually between 3 and 4 p.m.

   - After 10 minutes, stir the water in the cups with the thermometers and record the temperatures. (NOTE: These measurements should be taken at the same time.)

   - Use these results to complete the calculation on the following page. Determine the number of calories – or the amount of solar heat – received on 1 square centimeter in one minute at your location.

Scientist have measured the amount of solar energy beyond our atmosphere at about 2.0 calories per square centimeter per minute. About 1.5 calories per square centimeter per minute reaches earth after passing through atmosphere. This is the solar constant.

4. After the experiment, have students consider how solar energy could be applied to their everyday lives. What inventions or modifications to existing systems would be practical for using solar energy? Could passive solar energy be used effectively by schools since most school buildings are not used at night? What about electric school buses? Have students explain their ideas and how they could save nonrenewable energy resources.

## Solar Energy Calculation

**Area** = $\frac{\pi d}{4}$ = ____________ square centimeters

**Calories** = $\frac{\text{ml of } H_2O \text{ in 1 cup x difference in temperature of both cups after being in the sun for 10 minutes}}{\text{Area (square centimeters) of water x 10}}$

The "calories" calculation is the same amount of solar heat received on one square centimeter in one minute at your location. Multiply x 10,000 to get results for 1 square meter.

**Just do it!**

***Select solar powered calculators and other solar powered items. They save energy and reduce waste and you never have to replace batteries!***